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Association between Changes in Taste Thresholds and Cooking and Eating Experience of Japanese Cuisine

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Introduction

Taste perception is an important factor not only for sustenance, but also for enjoying food and improving the quality of life[1]. Taste perception plays a significant role as it determines what foods are selected and influences how much we eat[2]. Thus, taste perception is considered to be associated with health and well-being. Some researchers have found that taste perception, or lack of thereof, is also linked to the risk of various diseases, and there have been many studies about this association. For instance, a decrease in taste perception of saltiness has been associated with a risk of gastric cancer[3-5]. Pepino et al.[6] reported that obese women have lower umami taste sensitivity when compared with normal-weight women. Moreover, overweight children have lower taste perceptions of saltiness, bitterness, and umami than children with normal weight[7].

In Japan, the number of patients seeking treatment for taste disorders is 240,000 a year[8]. Although the influence of aging on taste sensitivity has been investigated in many studies[9,10], it has recently been reported that Japanese youth suffer from taste disorders as well[11,12]. Ohmori et al.[13] tested taste sensitivity in Japanese collegiate women using a simplified screening method, and reported that more than half of them were evaluated with decrement or abnormal taste sensitivity. As poor taste sensitivity causes a preference for strongly seasoned food and biased dietary habit, it leads to the promotion of lifestyle related diseases[14]. It is believed that good taste perception is important for good health. The good news is that taste perception can be improved through consecutive training in principle[15].

Traditional Japanese cuisine emphasizes the combination of the five basic tastes (sweetness, sourness, saltiness, bitterness, and umami)[16] and the utilization of natural tastes of diverse ingredients[17]. Characteristic soup stock,

which is called "*dashi*," in traditional Japanese cuisine contains lots of umami and is widely used for cooking[18]. Taking advantage of umami taste or inherent taste of food contributes to increasing the palatability of a low-seasoning diet. We considered that consecutive practices of cooking and eating traditional Japanese cuisine could raise the level of taste sensitivity. We therefore attempted to demonstrate that taste thresholds could be improved through scheduled training, preparing, and eating traditional Japanese cuisine.

Methods

Subjects and study design

Forty-one female college students who took a semester-long course in cooking traditional Japanese cuisine participated in this study. This course was composed of 15 weekly practices, and subjects acquired the fundamental skill or knowledge of traditional Japanese cuisine through these practices. For example, subjects learned how a knife is used, how *dashi* is prepared, how traditional Japanese meals are cooked, and how Japanese cuisine menu is planned. This cooking course was held for first-year students and their first practice was scheduled immediately after they joined the university. The protocol was approved by the Ethical Committee of Kinjo Gakuin University.

The experiment was performed during the first semester in 2015. Subjects underwent measurement of taste thresholds and questionnaires about their lifestyle. These measurements were performed twice: before and after the semester.

Taste thresholds

Differential thresholds for the five basic tastes were determined according to whole-mouth gustatory methods. The compounds used were taste solutions dissolved in bottled water. Samples were prepared for assessment of sweetness (sucrose), sourness (citric acid), saltiness (sodium chloride), bitterness (caffeine), and umami (sodium glutamate hydrate) using serial dilution methods (Table 1). The solutions of the lowest concentration of each taste was numbered 1 and the highest was numbered 5. Starting with the lowest concentration of each taste quality, participants were instructed to put and taste the 15ml of solution in their whole mouth, increasing it incrementally. They were not allowed to swallow it, and the mouth was rinsed with bottled water between each taste session. The lowest concentration at which the quality of the taste was correctly identified was defined as the recognition threshold. The concentrations of each taste were serially scored from 1 (lowest) to 5 (highest). When the subject could not detect the taste at the highest concentration, a score of 6 was given.

Table 1. Concentration of each taste compound

Taste	Solute		1	2	3	4	5
Sweetness	Sucrose	(%)	0.0530	0.1060	0.2110	0.4200	0.8400
Sourness	Citric acid	(%)	0.0019	0.0038	0.0077	0.0154	0.0307
Saltiiness	Sodium chloride	(%)	0.0190	0.0370	0.0740	0.1450	0.2990
Bitterness	Caffeine	(%)	0.0025	0.0050	0.0100	0.0200	0.0400
Umami	Sodium glutamate hydrate	(%)	0.0187	0.0374	0.0748	0.1496	0.2992

Questionnaires

Participants were asked to answer multiple-choice questionnaires about their dietary habits, food preference, and physical activity. Questions items were as follows: frequency of eating breakfasts/convenience or retort-packed foods/confectionery, frequency of drinking refreshing beverages, frequency of eating alone (≤1 times/week, 2-3 times/week, 4-5 times/week, or ≥6 times/week), preference for sweet/sour/salty/bitter stuff (like, tend to like, tend to dislike, or dislike), presence or absence of habitual exercise experiment, and length of time spent in sedentary behavior.

Statistical analyses

Statistical significance was set at values of $p < 0.05$ for all analyses. Comparisons between results of before and after semester were performed using Wilcoxon's signed-rank test. Differences in taste thresholds between before and after semester measurements was examined by Mann-Whitney U test. Correlations between taste thresholds and dietary habits, food preference, and physical activity were assessed by Spearman rank-correlation coefficient. All statistical analyses were performed using SPSS Statistics (version 20; IBM Corp., Somers, NY, USA).

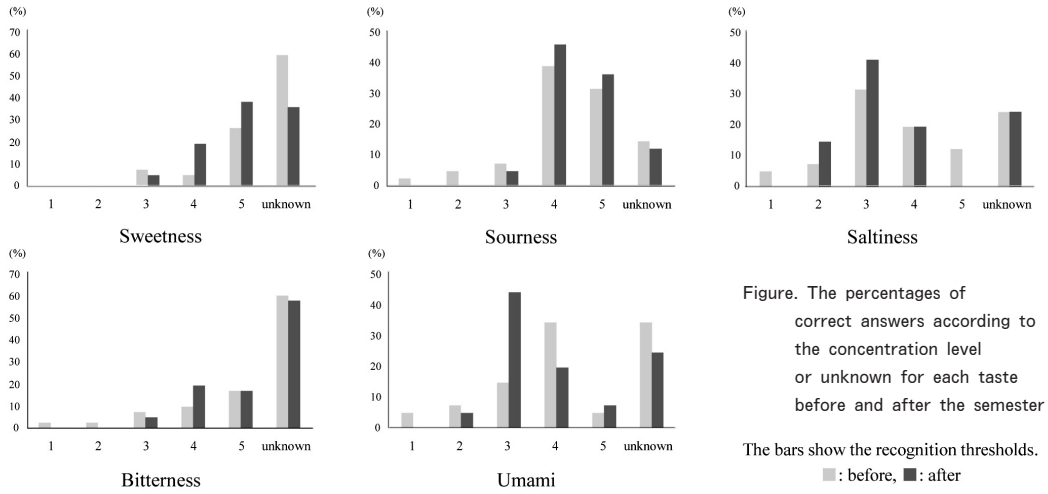

Figure. The percentages of correct answers according to the concentration level or unknown for each taste before and after the semester

The bars show the recognition thresholds.
: before, ■: after

Results

The percentages of correct answers for the five tastes before and after the semester were sweetness (39.0% vs. 63.4%), sourness (85.4% vs. 87.8%), saltiness (75.6% vs. 75.6%), bitterness (39.0% vs. 41.5%), and umami (65.9% vs. 75.6%), respectively. The figure shows the percentages of correct answers according to the concentration level or unknown for each taste. The number of subjects who improved or maintained the taste threshold increased significantly for sweetness and only slightly for umami following the course (Table 2). Changes in taste thresholds were not significantly affected by subjects' eating behavior or physical activity.

Table 2. Changes of the taste thresholds before and after the sementer

Taste	Frequency			p value
	Improvement	Maintenance	Aggravation	
Sweetness	17	18	6	0.039
Sourness	10	19	12	0.195
Saltiness	16	13	12	0.728
Bitterness	11	18	12	0.350
Umami	20	12	9	0.094

Discussion

According to our measurements before the semester, the peaks of each taste threshold for female collegiate students were sweetness (0.8400%), sourness (0.0154%), saltiness (0.0740%), bitterness (0.0400%), and umami (0.1496%), respectively. A previous study[19] which assessed the taste recognitions for Japanese female junior college students from 1986-1995 reported that the peaks of four taste thresholds were sweetness (0.8763%), sourness (0.0144%: tested by using lactic acid), saltiness (0.1496%), and bitterness (0.0621%), respectively. Our subjects had comparable or good cognitive capacities when compared with subjects in the previous study, although they had more variability in the capacities. Recently, the decrease in perception for taste among the Japanese youth is being considered as a problem. It is being assumed that this problem has been caused by the change in food product industry or the growth of the food-service industry[19]. We have to select things which we eat from a huge number of options, and repeat that every day as our dietary habits. It is important for the Japanese youth to acquire the habit of looking after their health themselves and learn to choose food they usually eat according to their ideas.

In the present study, we suggested that taste perception has the potential to improve through training. As taste perception is affected by changes in dietary habits[15], reported that saltiness threshold improved based on consecutive intake of low-salt diet in patients who had

chronic kidney diseases. This previous study showed that the taste perceptions were affected by what one eats. On the other hand, there are also instances where taste thresholds were improved not by diet but physical training. Ito et al.[20] reported that patients with chronic obstructive pulmonary disease who performed the 4-week pulmonary rehabilitation, their taste recognition thresholds for sweetness, saltiness, and sourness improved significantly. Although, changes in taste thresholds were not correlated with participants' habitual physical activity in our study, it might be effective for the taste thresholds to combine use of dietary and physical treatment.

Strength of our study is measurements before and after consecutive training for cooking and eating traditional Japanese cuisine. This cuisine emphasizes seasonality and it uses the ingredients to its maximum advantage as they come into season. Moreover, this cuisine is typically seasoned with a combination of *dashi* (soup stock), sugar, salt, vinegar, soy sauce, sake, and mirin. For these reasons, it is considered that traditional Japanese foods are well balanced containing the five basic tastes[16]. Our participants may have been able to improve their taste perceptions because of consecutive cooking and eating traditional Japanese meals. Moreover, when preparing traditional Japanese cuisine, we can reduce the use of salt by incorporating the umami taste such as *dashi* and natural tastes of ingredients. Our study reported that salty taste threshold did not improve by consuming traditional Japanese meal once a week only. It is thought that taste perception for saltiness also improves by habitually eating traditional Japanese meals with a focus on salt reduction for once or more than once a week.

In conclusion, gustatory thresholds for sweet taste and umami can be improved through an accumulation of cooking and eating experience of traditional Japanese cuisine, independent of dietary or physical activity patterns. In the long run, these changes in taste perceptions could influence eating behaviors such as food choices, and our results may contribute to good health. Further research is needed on the correlation between taste perception, body mass, and continuous cooking and eating of traditional Japanese cuisine.

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